TABLE 4-5

SUMMARY COUNT OF STATION CLASSES PER AGENCY AND SERVICE IN THE 2200-2290 MHz BAND, AS OF JUNE 1990

Agencies and Totals per Agency[a]	Fixed Service	Mobile Service	Aeronautical Mobile Service	Land Mobile Service	Maritime Mobile Service	Meteorological Satellite Service	Space Operation Service	Space Research Service	No Specific Service	
									Space	Experimental
A 22 (0.9%)	22									
AF 1120 (43.4%)	17	449	1	1					276	376
AR 398 (15.4%)	114	246	5	1						32
C 7 (0.3%)		2				5				
CG 32 (1.2%)	29	2			1					
DOE 266 (10.3%)	38	226								2
FAA 7 (0.3%)	7									
FEMA 8 (0.3%)	8									
GSA 2 (0.0%)	2									
I 8 (0.3%)	8									
J 2 (0.0%)	2									
N 459 (17.8%)	27	339	9		5					79
NASA 184 (7.1%)	7	56			3	5	7	69	17	20
NG 23 (0.9%)										23
T 12 (0.5%)	3	2	4							3
TRAN 20 (0.8%)	20									
Totals per Service	308 (11.9%)	1322 (51.2%	19 (0.7%)	2 (0.0%)	9 (0.1%)	10 (0.4%)	7 (0.3%)	69 (2.7%)	293 (11.4%)	543 (21.0%)

[a]The percentages of the total station classes per agency and service are rounded-off.

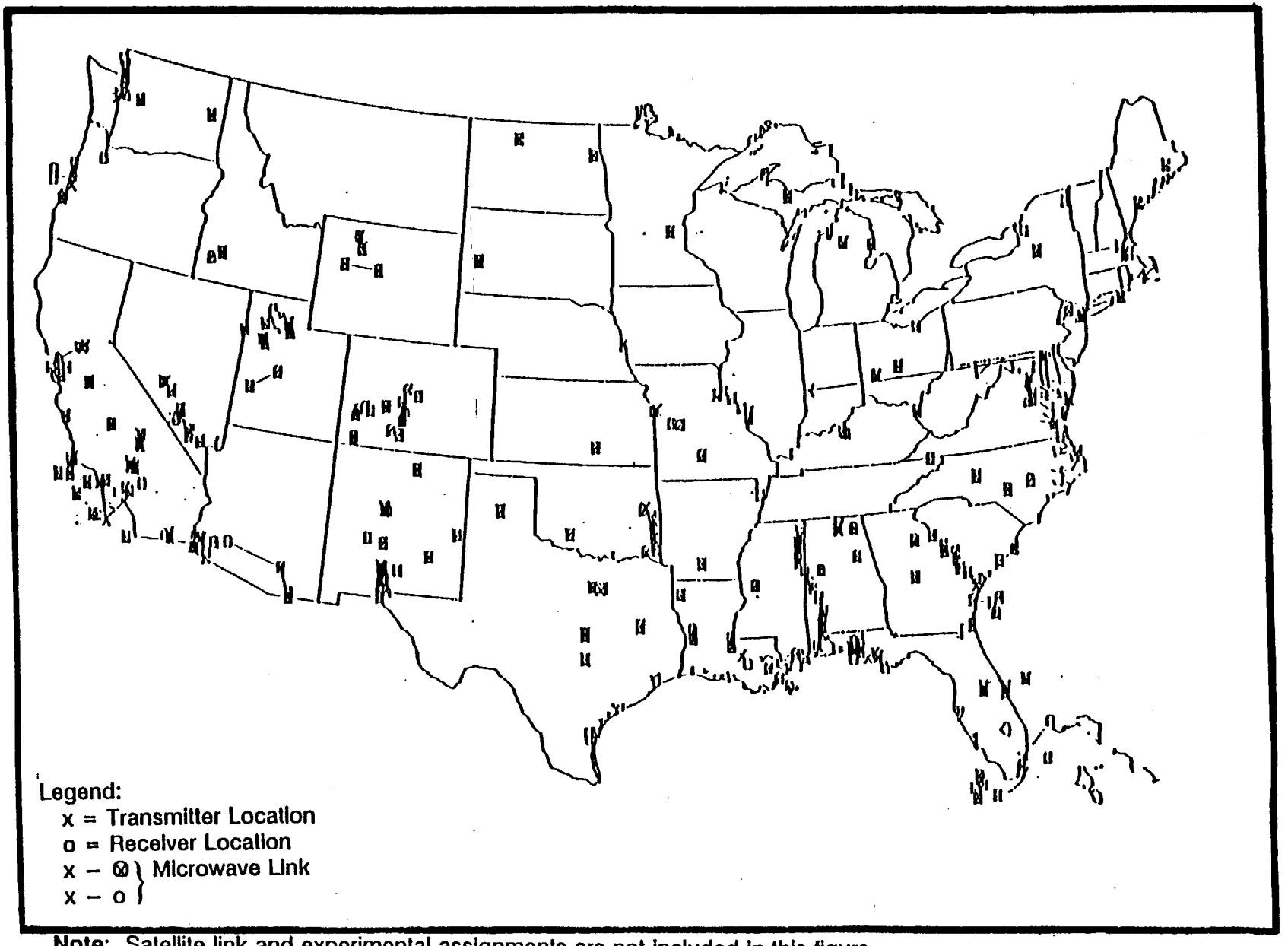
The growth rate of frequency assignments in this band, which is approximately 80 new assignments per year for the past 10 years, is conservative compared to the growth rate in the 1710-1850 MHz band. It should be noted, however, that in the 1710-1850 MHz band a frequency range of 140 MHz is available compared to only 90 MHz frequency range for the 2200-2290 MHz band. Most importantly, space operations which predominate in this band cannot be evaluated alone by frequency assignment growth rate, but also by frequency bandwith per use which is more representative of space usage and growth.

The geographical distribution of all authorized frequency assignments in the 2200-2290 MHz band is presented in Figure 4-7. An observation of Figure 4-7 will indicate that these frequency assignments are sparsely distributed across the Continental U.S. (CONUS), with the exception of a few locations such as; California, Florida, New Mexico, and others. It should be noted, however, that satellite link assignments are not included in the figure because locations of receiving earth stations might be compromised. Experimental assignments are also not included. A solid line joining two or more earth stations indicates a microwave link. Figure 4-8 is a graph of the frequency assignment distribution per state in the 2200-2290 MHz band. As before, the shaded columns represent the total number of frequency assignments or operational transmitters in a state, as indicated on the ordinate.

The distribution of frequency assignments per megahertz across the 2200-2290 MHz band is given in Figure 4-9. The ordinate specifies the frequency assignment count per megahertz channel interval starting at 2200 MHz. The two most extensively used frequencies are the 2260 MHz and 2280 MHz. Each of these two channels has about 95 or more assignments. Again, the distribution only reflects the assignment count per megahertz bin and does not necessarily include the total number of equipments represented by these assignments.

Spectrum Use Measure (SUM) in the Continental U.S. (CONUS) (See Refs. 6 and 7.)

Figures 4-10 and 4-11 show the spectrum use bandwidth (SUB) and factor (SUF) for the 2200-2290 MHz band in the CONUS, respectively. Similar conditions were applied for this band as in the 1710-1850 MHz band in generating the figure except that the reference used is a mobile system.



Note: Satellite link and experimental assignments are not included in this figure.

Figure 4-7. Geographic distribution of assignments in the 2200-2900 MHz band.

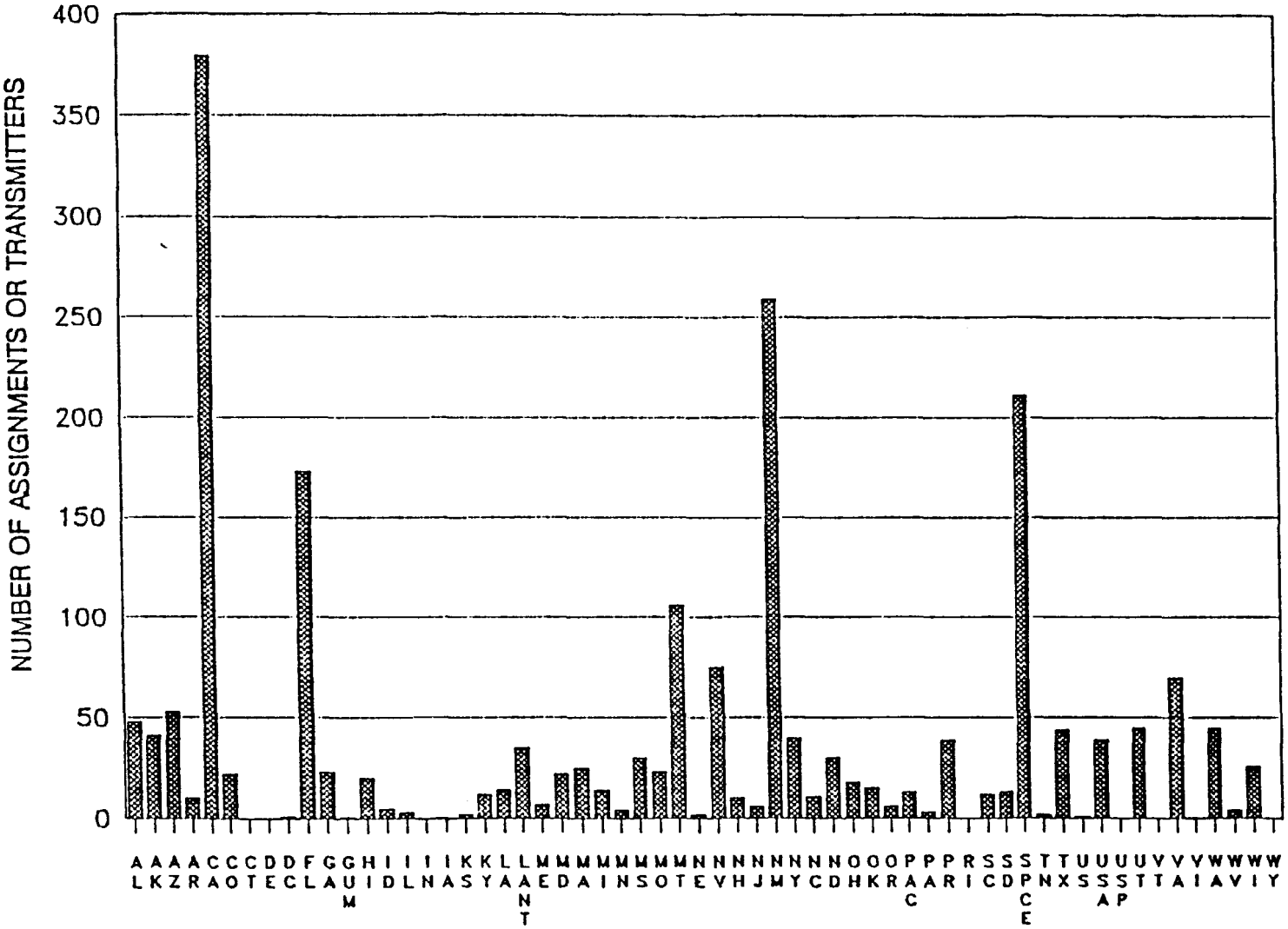


Figure 4-8. Frequency assignment distribution per state in the 2200-2290 MHz band.

Note:

Guam	-	Guam	PAC	-	Pacific Ocean
LANT	-	Atlantic Ocean	SPCE	-	Space

US - When transmitting and/or receiving in all 50 states of the U.S. and the District of Columbia.

USA - When transmitting and/or receiving in the 48 contiguous states of the U.S. and the District of Columbia.

USP - When transmitting and/or receiving throughout the U.S. (50 states and the District of Columbia), the Commonwealth of Puerto Rico, and the Territories and Possessions, excluding the Trust Territories of the Pacific Islands.

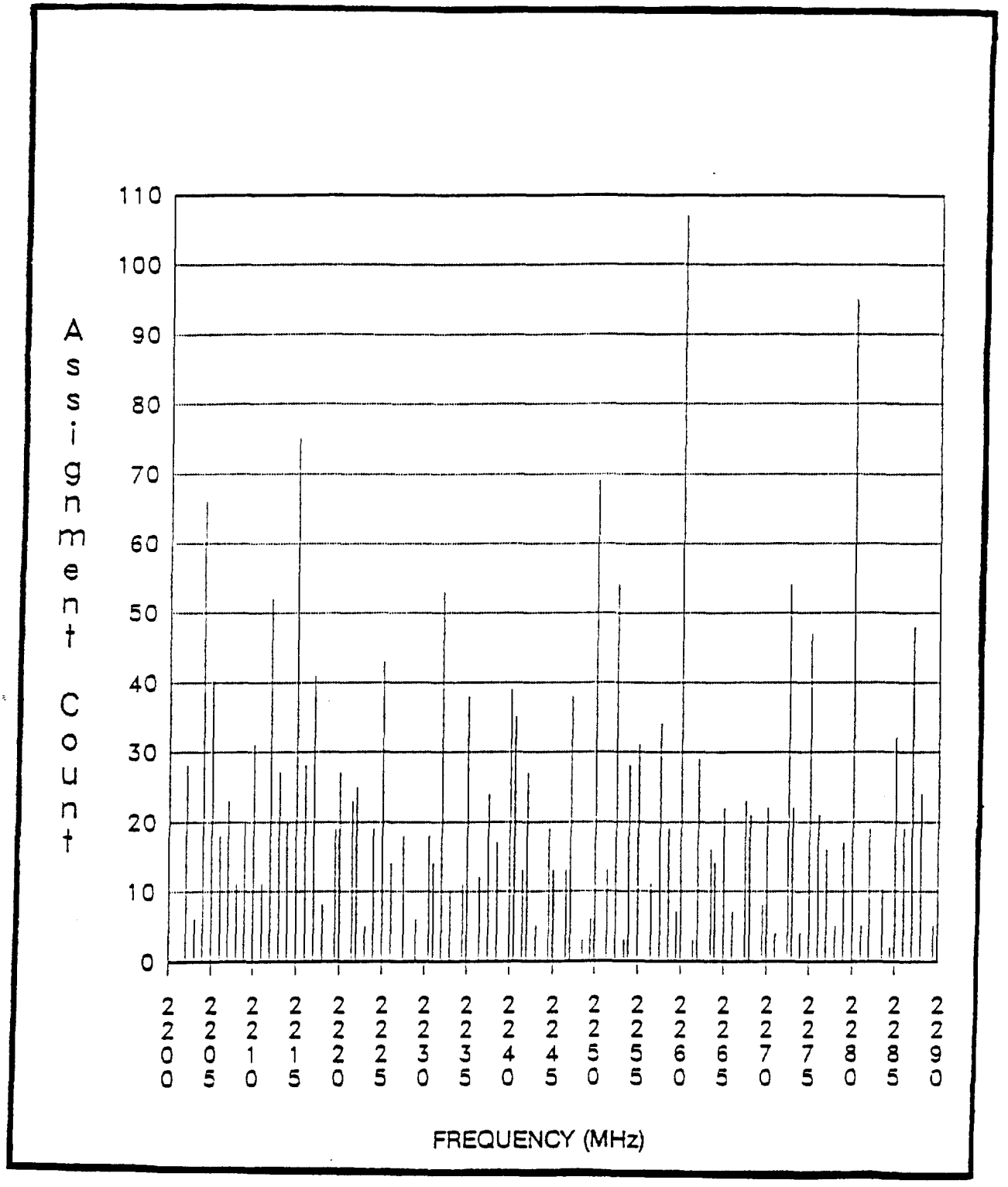


Figure 4-9. Frequency assignment distribution per Megahertz Bin in the 2200-2290 MHz band.

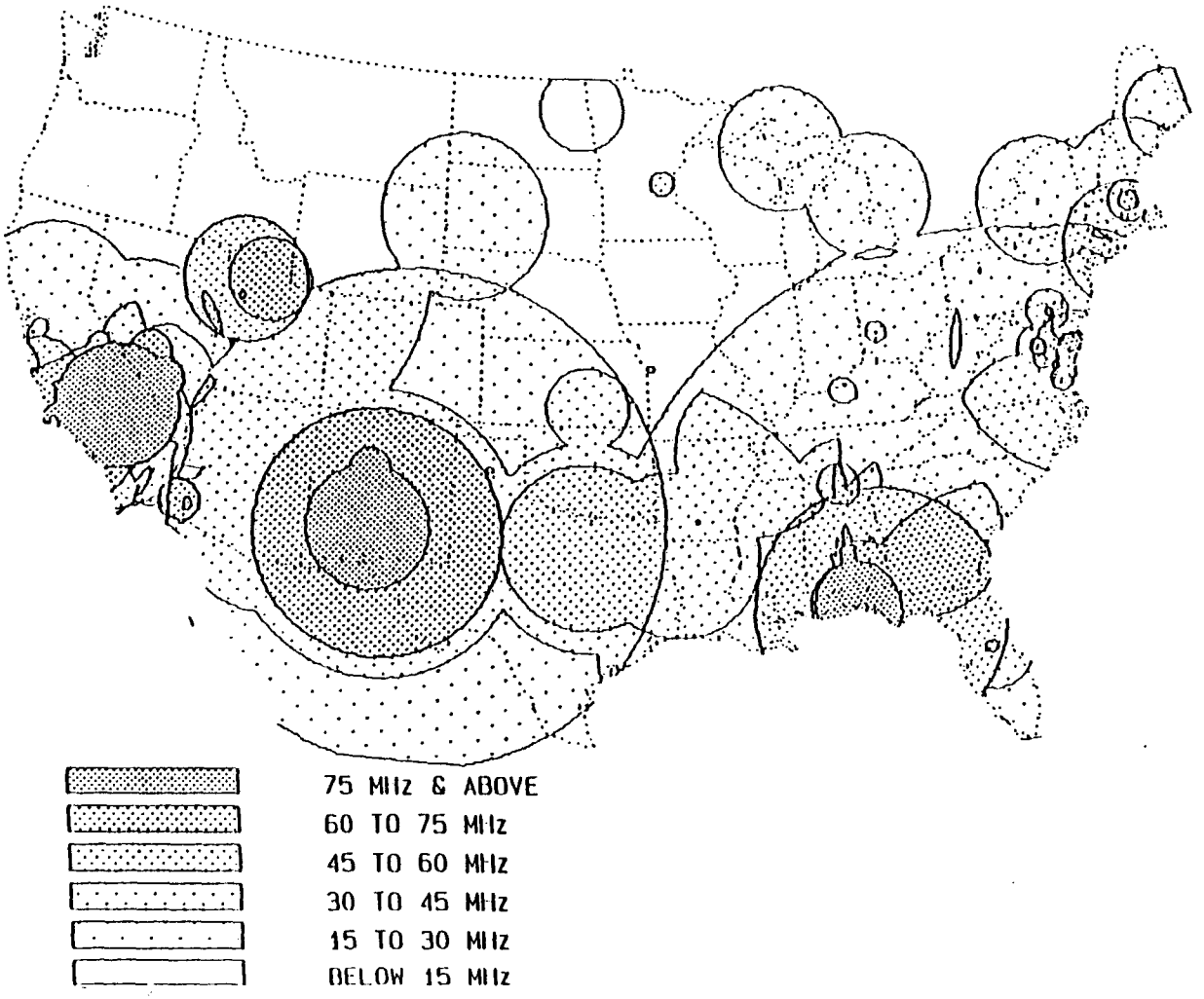


Figure 4-10. Areas of the United States with various ranges of spectrum use bandwidth (SUB) values in the 2200-2290 MHz band.

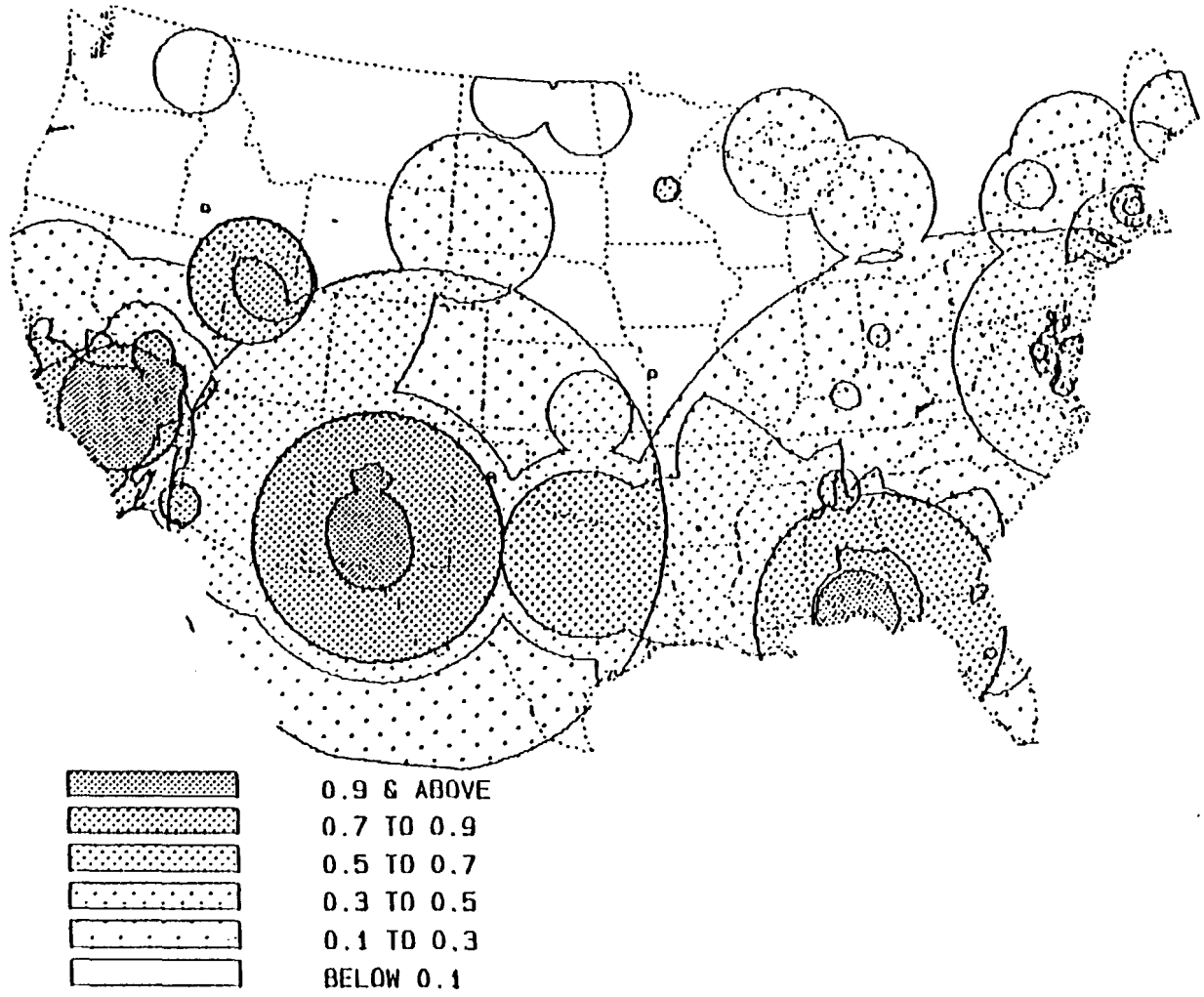


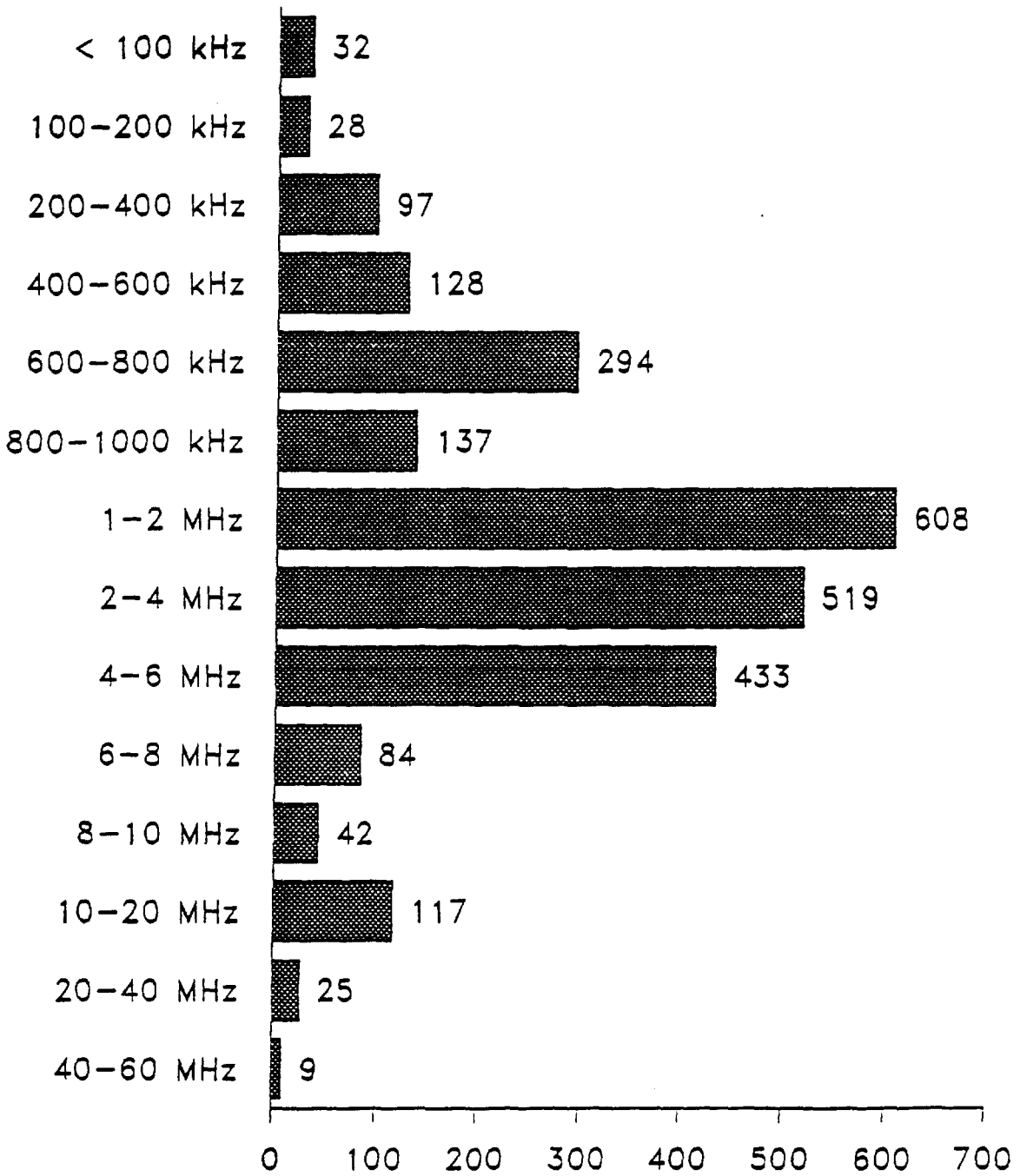
Figure 4-11. Areas of the United States with various ranges of spectrum use factor (SUF) values in the 2200-2290 MHz band.

Emission Characteristics

The 2200-2290 MHz band being the "sister band" of the 1710-1850 MHz (i.e., downlink band for the uplink transmissions in 1710-1850 MHz) also supports a wide variety of systems. Besides accommodating the fixed, mobile, and space research services, it also supports the space-to-space and space-to-Earth operations in the earth exploration-satellite and space operations services. Further, aeronautical telemetering is permitted in the band. The diversity of equipment currently operating in the band presents a difficulty in the spectrum management matter, as in the case of a channeling plan, because of varying bandwidths. In this band, the operational emission bandwidths of equipment ranges from 10 Hertz up to 40 MHz, excluding experimental assignments. The majority of these emission bandwidths are concentrated in the 600 kHz and 6 MHz range, as seen in Figure 4-12.

There are at least 42 emission types for equipment currently registered in the band. However, the vast majority of these equipments are in one of the following categories of emission types; F2D, F9W, F9D, G7W and G9D.

The predominant emission bandwidths, emission types, and station classes used by each agency in the 2200-2290 MHz band is shown in TABLE 4-6. As before, the emission bandwidths listed in the table do not necessarily correspond to the emission types or the station classes listed alongside them.



Note: The bandwidth occurrence values are inclusive of the lower limits of the various bandwidth ranges.

Figure 4-12. Distribution of emission bandwidths in the 2200-2290 MHz band.

TABLE 4-6

EMISSION DESIGNATORS AND STATION CLASS PREDOMINANTLY USED BY EACH AGENCY IN THE 2200-2290 MHz BAND

AGENCY	EMISSION BANDWIDTH (MHz)[a]	EMISSION TYPE[b]	STATION CLASS
AGRICULTURE	2.18 4.66 7.23	F9W	FX
AIR FORCE	0.75 3.26 5.00	G9D G7W F7D P0N	XT MOEA EK ER
ARMY	0.80 1.00 1.60 6.00	F9W G9D F9D M7D	FX MOEA MOEB
COMMERCE	0.308 2.05 7.00	G1D G2D F1D	EMER MOEB
COAST GUARD	0.80 5.00	F8W F9W	FX
ENERGY	1.00 3.00	F9D	MOEA MOEB MOEC
FEDERAL AVIATION ADMINISTRATION	0.80 10.00	F9W	FX
FEDERAL EMERGENCY MANAGEMENT AGENCY	5.00	F8W	FX
GENERAL SERVICES ADMINISTRATION	10.00	F7W	FX
INTERIOR	0.80 1.60 2.20	F9W	FX
JUSTICE	2.00	F9W	FX
NAVY	0.50 0.60 1.00 1.50	F2D	MOEA XT
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION	0.50 3.00 5.00 6.00	G9D F9D	MOEB THTK THTR
TREASURY	0.20	F2D F9W	FAD FX XT
TRANSPORTATION	10.00	F7D F8E	FX

[a]The emission bandwidths do not necessarily correspond to the emission types or station classes listed along side them.
[b]Defined in the NTIA Manual.

SECTION 5
SUMMARY OF MAJOR UNCLASSIFIED SYSTEMS IN THE 1710-1850 MHz BAND

INTRODUCTION

For this report, the sources of data to identify the various existing and future (planned) major systems in the 1710-1850 MHz band were the GMF, Systems Review documentation, previous NTIA reports, and other Federal agencies' technical reports. Included in these sources is an NTIA report on Government Space Services.[8] These sources were also used to gather information with regards to the functional description and some technical characteristics of the systems. The result of the review performed on the data indicated that most of the major systems identified in Reference 3 are still operational to date. Hence, some elements of Section 3 of Reference 3, were reproduced in this section of the report. Specifically, the functional description, as well as the technical parameters, of systems discussed in the reference.

GENERAL

The spectrum allocation rules and regulations applicable to the 1710-1850 MHz band permit a wide variety of systems to operate in the band which includes fixed, mobile, and space systems. In addition to those specifically permitted by the allocation tables, a number of experimental and special purpose stations have also been identified as operating in the band.

In order to summarize the large variety of systems, it was necessary to categorize the equipment. The technique chosen for this report was similar to the method used in Reference 3 -- that is to group the systems first into major service categories, (e.g., Fixed and Aeronautical Mobile) with a further breakdown into functional uses (e.g., radio relay and telecommand). This method helps to highlight overall trends for the band. Other methods of grouping the systems may also prove useful such as ordering by agency, geographic area, and others.

TABLE 5-1 gives a summary list of the major unclassified systems, identified to date, operating or planned for operation in the 1710-1850 MHz band. It includes an estimate of the Federal Government's initial and replacement costs. Normally, the initial cost portrays the dollar amount during the year of program inception. In some cases, however, the initial cost including the replacement cost were derived based on current available documentation. Unless otherwise specified, the replacement cost for space, mobile and radio astronomy systems is calculated by

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[8] Haines, R., *Spectrum Resource Assessment of Selected U.S. Government Space Services*, NTIA TM-88-136, U.S. Department of Commerce, September 1988.

TABLE 5-1
(page 1 of 3)

SUMMARY LIST OF MAJOR UNCLASSIFIED SYSTEMS IN THE 1710-1850 MHz BAND AND ESTIMATED FEDERAL GOVERNMENT'S INITIAL AND REPLACEMENT COSTS[a]

SYSTEM	NUMBER OF UNITS	UNIT COST ($MILL.)	INITIAL COST ($MILL.)	REPLACEMENT COST[b] ($MILL.)
1. SPACE SYSTEMS*				
A. Ground Elements				
(1) Space Ground Link Subsystem (SGLS)	15[c]	NA	NA	618[d]
(2) Automated Remote Tracking System (ARTS)	14	4.3	60	66
(3) NAVSTAR GPS - Operational Control Segment (GPS-OCS)	5	5	25	54
B. Space Elements*				
(1) Space Shuttle	4	300[f]	1200	4000
(2) Fleet Satellite Communication (FLTSATCOM)	NA	NA	NA	NA
(3) Fleet Satellite Communication-C (FLTSATCOM-C)	10[g]	NA	NA	N/A
(4) Defense Satellite Communication System Phase II (DSCS-II)	16	NA	1179[h]	1899[h]
(5) Defense Satellite Communication System Phase III (DSCS-III)	14	73.7[i]	1032	1662
(6) Defense Satellite Communication System Follow-On	NA	NA	2000[j]	N/A
(7) NAVSTAR Global Positioning System (GPS)	24[k]	100	2400	7532
(8) Space Test Satellites (P78-2, P80-1 and P86-1)	3	21.4	64[l]	103
(9) Defense Meteorological Satellite Program (DMSP)	4	NA	NA	NA
(10) Array of Low Energy X-Ray Imaging Sensors (ALEXIS)	1	2	4[m]	N/A
(11) Instrumented Test Vehicle (ITV), SGLS	10	5.9	59	71
(12) Inertial Upper Stage (IUS)	25	NA	NA	NA

NA = Not Available
N/A = Not Applicable. System is either in developmental or completion stage.

*Some of these systems belong to one or more radio services. Their operation in this band, however, is under the space operation service.

TABLE 5-1
(page 2 of 3)

SYSTEM	NUMBER OF UNITS	UNIT COST ($MILL.)	INITIAL COST[a] ($MILL.)	REPLACEMENT COST[b] ($MILL.)
2. FIXED SERVICE				
A. Line-of-Sight, Point-to-Point Systems				
(1) Department of Agriculture	1373	0.030	41	81
(2) Department of Energy	647	0.076	49	130
(3) Department of Interior/TVA	378[n]	0.050	19	43
(4) Department of Justice/FBI	723	0.062	45	89
(5) Federal Aviation Administration	239	1.50	350	365
(6) Air Force	226	0.037	8	22
(7) Navy	246	0.036	9	24
(8) Other Federal Agencies	1015	0.050[o]	51	114
B. Vessel Traffic System	NA	NA	33[p]	64
C. Test Ranging Timing Distribution Systems	NA	NA	NA	NA
D. Military Tactical and Training Systems				
(1) AN/GRC-50	NA	NA	NA	NA
(2) AN/GRC-103	400	0.183	73	142
(3) AN/GRC-226[q]	2325	NA	NA	NA
E. ACMI/ACMR/TACTS[r]	SEE	MOBILE	SERVICE	

[a] There are some cases where the estimated initial cost specified by an agency for fixed systems differ from the cost stated in this table. This is because, in the table, the actual fixed assignments count is used as the number of stations or units as opposed to the agency's assumed number of stations.

TABLE 5-1
(page 3 of 3)

SYSTEM	NUMBER OF UNITS	UNIT COST ($MILL.)	INITIAL COST ($MILL.)	REPLACEMENT COST[b] ($MILL.)
3. MOBILE SERVICE				
A. Packet Radios	NA	NA	3[s]	9
B. Tethered Radar Balloons/SEEK SKYHOOK	NA	NA	8[t]	16
C. Air/Ground Video/Data Links				
(1) Airborne Units	NA	NA	NA	NA
(2) Ground Units	NA	NA	NA	NA
D. Aircraft Combat Training Systems				
(1) ACMI	7	28.9[u]	202	634
(2) ACMR	7	20[u]	140	439
(3) TACTS	3	NA	NA	NA
E. Scoring Systems (Telemetry Links)				
(1) Airborne Units	NA	0.030[v]	NA	NA
(2) Ground Units	NA	NA	8[w]	11
4. Radio Astronomy				
A. Very Long Baseline Array Systems	NA	NA	70	113
B. Very Large Array Systems	NA	NA	NA	NA
C. Interferometer Systems	NA	NA	NA	NA
D. Various Radio Telescope Systems	NA	NA	NA	NA

FOOTNOTES TO TABLE 5-1

[a]The initial and replacement costs are based on the latest available documents. These are non-recurring costs only.

[b]When specific estimates are not available, the replacement cost is either based on an assumed annual inflation rate of 10% (e.g., for space systems, mobile systems, etc) or cost of $250,000 per new station (e.g., for fixed line-of-sight, point-to-point systems). For systems in the developmental or completion stage, the replacement cost is assumed to be at least the initial cost.

[c]Nine tracking ground stations located worldwide and a proposed 6-mobile ground terminals.

[d]The value includes procurement of six new mobile ground terminals and maintenance support.

[e]All of the listed Space Elements use the 2200-2290 MHz band for downlink telemetry.

[f]Initial cost for the first space shuttle.

[g]Includes two spare satellites.

[h]The computed value is based on the DSCS B8 satellite cost.

[i]Cost for the B8 satellite.

[j]Initial cost for the DSCS Follow-on Program.

[k]Includes 3 spare satellites.

[l]Based on the P80-1 cost of $21.4 million.

[m]Two million is for the satellite control, telemetry and tracking links (AF's project). The other two million is for DOE's initial investment for ALEXIS. ALEXIS is still under developmental stage.

[n]Includes frequency assignments for Tenessee Valley Authority.

[o]Assumed cost per fixed link.

[p]The value includes the cost for the Vessel Traffic Systems in New Orleans, Alaska, New York and Washington.

[q]The AN/GRC-226 is a part of the Mobile Subscriber Equipment (MSE) System. The initial cost of the MSE system is $4.3 billion.

[r]Air Combat Maneuvering Instrumentation/Air Combat Maneuvering Range/Tactical Aircrew Combat Training Systems.

[s]Cost only includes hardware and development of experimental systems for the DARPA Upgraded Packet Radio.

[t]The cost only includes the AF system operating in Cape Canaveral, FL.

[u]The value includes equipment, installation and aircraft pods costs.

[v]The cost is based on the Bullet Hit Indicator and Vector Miss Distance Indicator Systems.

[w]The cost only includes the Floating at Sea Target Scoring System.

multiplying the difference between the current (1990) and program inception years by an assumed, average, annual inflation rate of 10%, and then adding the product to the initial cost. For fixed, line-of-sight, point-to-point systems, the replacement cost is determined with the assumption that existing networks will be reallocated to a higher frequency band (e.g., 7-8 GHz band) and 25% of the existing facilities will require at least one intermediate relay station (site). The approximate cost, which includes land acquisition, facility construction and equipment procurement, is $250,000 per site. Thus, the replacement cost, unless specified by an agency, is calculated by multiplying $250,000/site by the number of new sites and adding the product to the initial cost of the system. The expanded version of the summary list, which provides several key parameters including frequency, power, environment, etc., is presented in TABLE 5-2. The table also includes statistics for systems operating in the 2200-2290 MHz band. Figure 5-1 presents a pictorial representation of several of the major classes of systems to illustrate the complexity of the spectrum management problems associated with both the 1710-1850 MHz and 2200-2290 MHz bands.

A short functional summary of the major systems in the 1710-1850 MHz band is given in subsequent paragraphs. Since the 1710-1850 MHz and the 2200-2290 MHz are similar bands in terms of allocation, it is expected that some of the systems operating in one band are also employed in the other. This is specifically the case with some space systems and satellite networks described below wherein the low band is used for uplink transmissions and the high band is for downlink transmissions. In cases where this situation prevailed, the system description was depicted once and referred to if necessary.

The current space usage in the band is primarily limited to systems operated by the U.S. Air Force and NASA. These systems or satellite networks are enumerated and briefly discussed under their respective service title categories. A special system, the Space Ground Link Subsystem (SGLS) under the direction of the Air Force Satellite Control Network (AFSCN) which is used to support spacecraft requiring downlink telemetry, is described under "Space Systems."

The classification of system description and mission of many military satellites prohibits the publication of systems or equipment characteristics in this report.

MAJOR UNCLASSIFIED SYSTEMS OPERATING OR PLANNED FOR OPERATION IN THE 1710-1850 MHz BAND

SPACE SYSTEMS

Space Ground Link Subsystem (SGLS)

The SGLS is a system in operation by the Air Force to provide tracking, telemetry, and control for DOD orbiting satellites. Both geostationary and non-geostationary satellites are

TABLE 5-2
(page 1 of 2)

SUMMARY OF KEY PARAMETERS OF SELECTED SYSTEMS IN THE 1710-1850 MHz AND 2200-2290 MHz BANDS

SYSTEM	AGENCY	FREQUENCY OF INTEREST (MHz)	ENVIRONMENT	# OF ASSIGNMENTS	POWER (watts)	G(t) (dBi)	G(r) (dBi)	EMISSION BANDWIDTH (MHz)
SGLS	AF	1761 – 1842 2200 – 2290	CA,GUM,HI,NH to Space Space to CA,GUM,HI,NH	169 168	10K 20	34 – 46 – 4 – + 3*	– 4 – + 3* 35 – 49	4.0 5.0
Space Shuttle	NASA DOD	1761 – 1842 2200 – 2290	Earth to Space Space to Space Space to Earth	2 8	–	–	–	4.0 –
STDN	NASA	2200 – 2290	Space to Earth	2	2K,10K	43,51	43,51	3
TDRSS/Augmented TDRSS	NASA	2200 – 2290	Space to NM Space to Space	33	0.84 –	0.3 –	– –	4.0
Space Station	NASA	2200 – 2290	Space to Space	NA	6 – 175	3 – 6.8	3 – 6.8	–
ALEXIS	AF DOE	1774 2260.5	NM to Space Space to NM	NA	50 10	18 2	– –	0.01 1.5
COBE	NASA	2287.5	Space to Space Space to VA	1	2.5 2.5	12 – 2.0	12 – 2.0	– 2.6
GOES	DOC	2209.086	Space to VA	6	3	3.5	12	0.08

TABLE 5-2 does not include all the major systems listed in TABLES 5-1 and 6-1; however, it includes at least a system representative of each of the services in TABLES 5-1 and 6-1.

*Spacecraft receive antenna gain NA - Not available

TABLE 5-2
(page 2 of 2)

SYSTEM	AGENCY	FREQUENCY OF INTEREST (MHz)	ENVIRONMENT	# OF ASSIGNMENTS	POWER (watts)	G(t) (dBi)	G(r) (dBi)	EMISSION BANDWIDTH (MHz)
OMV	NASA	2287.5	Space to Space Space to Earth	NA	2.5 & 15	–	–	–
Fixed, LOS	AGA	1710 – 1850 2200 – 2290	US&P	4847 308	1 – 40	24 – 33	24-33	0.80 – 10.0
Tactical & Training	AF AR	1710 – 1850 2200 – 2290	Army & AF Bases and Training Grounds	232[a] NA	1 – 25	6 – 19	6 – 19	0.50 – 26.0
TACTS/ACMI	NAVY AF	1710 – 1840 2200 – 2290	Test & Training Ranges and Sea	439 7	1 – 20	0 – 41	0 – 34	0.60 – 7.1
Packet Radios	AF AR	1710 – 1850	East Coast (U.S.)	11	10	9	9	20.0
SEEK SKYHOOK	AF	1720,1755,1820	Florida Keys	6	2	7	20	12.0 – 60.0
Tethered Balloons (AEROSTATS)	DOT	1725,1760,1785 2200-2290	NM,AZ	3 4	2	6	6	0.20
(Air – Ground) and (Air – Air) Video & Data Link	AF NAVY	1710 – 1850 2200 – 2290	US&P (Mostly in Test & Training Ranges)	136 1076	5 – 25	0 – 12	0 – 33	1.4 – 20.0
NB Scoring Systems	NAVY AF	1710 – 1850 2200 – 2290	Test & Training Ranges	38 NA	1 – 5	2 – 25	2 – 35	≤ 2.5
WB Scoring Systems	NAVY AF	1775,1800	Test & Training Ranges	6	0.001 – 225	3	3	≥ 50.0
Security Systems	AF	1720,1740,1760 1780,1800	MT,SD,ND	3	2.2	18	18	15.0
Radio Astronomy	NSF	1720 – 1721	Radio Astronomy Facilities	NA	–	–	–	–

[a]The Army also has temporary assignments (i.e., 200 assignments per network) to support their area-wide command and control network system.

NA - Not available

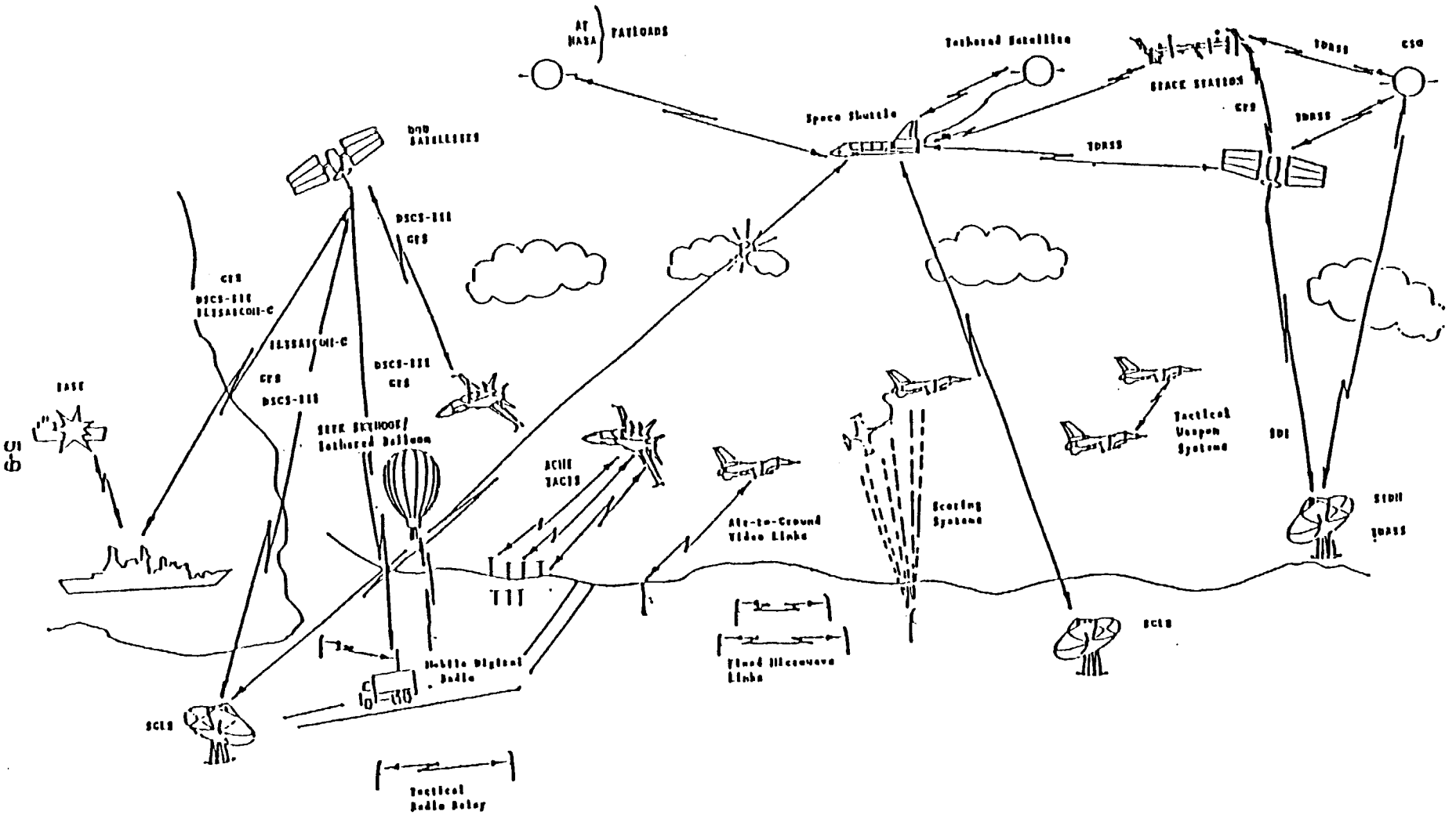

Figure 5-1. Pictorial representation of major systems in the 1710-1850 MHz and 2200-2290 MHz bands.

Note: The link between the GPS and the aircraft is a one-way link (i.e., from the satellite to the aircraft). This link and the up and downlinks between the DSCS-III and the aircraft are not in either of the bands covered by this SRA.

serviced from AFSCN ground stations located in Guam, Hawaii, New Hampshire, Colorado, California, and overseas. The RF links include command uplinks in the band 1761-1842 MHz and telemetry downlinks in the 2200-2290 MHz band. Tracking is accomplished by the use of narrowbeam ground station antennas combined with ranging using phase comparison techniques between the uplink signal and the return signal from the satellite-borne transponders. The uplink signal is transmitted with an E.I.R.P. of 86 dBW (10 kW power and 46 dBi antenna gain) and has an emission bandwidth of 4 MHz. Frequency assignments for 20 channels separated by approximately 4 MHz at each of the AFSCN stations have been authorized, which effectively excludes other users over the entire 1761-1842 MHz band around the four sites. TABLE 5-3 depicts the various SGLS channels and the corresponding uplink and downlink transmission frequencies. Continued operation of the SGLS will be required for at least the next 20-30 years to support DOD missions. The DOD also has transportable SGLS-compatible earth stations that provide additional coverage for launch and on-orbit operations. These transportable earth stations are used, for example, when fixed SGLS sites cannot provide required mission coverage.

Automated Remote Tracking Station (ARTS)

The ARTS is an upgrade to the SGLS. The upgrade includes replacing most of the antennas and adding a few new sites. The areas of operation for the ARTS include the following: Vandenberg AFB (CA), New Boston (NH), Kaena Pt. (HI), Andersen AFB (Guam), Falcon AFB, (CO), and selected overseas sites.

Space Shuttle

The Space Shuttle is a joint NASA and DOD program designed to support a wide range of scientific, environmental, defense, commercial, and international interests. It is a manned reusable space transportation system that could deliver satellites to low-Earth orbit where an upper stage can boost them into a higher-energy orbit. In addition to its launch capability, the shuttle also carries spacelab payloads, modules, and pallets used to conduct in-orbit experiments from the shuttle cargo bay. A fleet of five reusable orbital vehicles were planned with flights that began in the early 80's. However, the January 1986 Challenger ill-fated flight reduced the fleet to only three operational and one under construction. The communication links

TABLE 5-3

COMMAND AND TELEMETRY FREQUENCY RELATIONSHIP FOR SGLS
(from Ref. 3)

SGLS CHANNEL	UPLINK TRANSMISSION FREQUENCY ($f_{o_{uplink}}$) (±0.002%)	DOWNLINK RECEPTION FREQUENCIES (NOMINAL)	
		CARRIER I ($\frac{256}{205} f_{o_{uplink}}$)	CARRIER II ($\frac{256}{205} f_{o_{uplink}} - 5\ MHz$)
1	1763.721 MHz	2202.500 MHz	2197.500 MHz*
2	1767.725 MHz	2207.500 MHz	2202.500 MHz
3	1771.729 MHz	2212.500 MHz	2207.500 MHz
4	1775.733 MHz	2217.500 MHz	2212.500 MHz
5	1779.736 MHz	2222.500 MHz	2217.500 MHz
6	1783.740 MHz	2227.500 MHz	2222.500 MHz
7	1787.744 MHz	2232.500 MHz	2227.500 MHz
8	1791.748 MHz	2237.500 MHz	2232.500 MHz
9	1795.752 MHz	2242.500 MHz	2237.500 MHz
10	1799.756 MHz	2247.500 MHz	2242.500 MHz
11	1803.760 MHz	2252.500 MHz	2247.500 MHz
12	1807.764 MHz	2257.500 MHz	2252.500 MHz
13	1811.768 MHz	2262.500 MHz	2257.500 MHz
14	1815.772 MHz	2267.500 MHz	2262.500 MHz
15	1819.775 MHz	2272.500 MHz	2267.500 MHz
16	1823.779 MHz	2277.500 MHz	2272.500 MHz
17	1827.783 MHz	2282.500 MHz	2277.500 MHz
18	1831.787 MHz	2287.500 MHz	2282.500 MHz
19	1835.791 MHz	2292.500 MHz*	2287.500 MHz
20	1839.795 MHz	2297.500 MHz*	2292.500 MHz*
21	Frequency synthesizer providing continuous tuneability for downlink signals having frequencies ranging from 2202.5 MHz to 2292.5 MHz.		

*These frequencies are not allocated in the ITU tables or National tables for Space-to-Earth telemetry.

for the Space Shuttle are shown in Figure 5-2. The primary links of interest in the 1710-1850 MHz band are the SGLS command and control uplink from an Air Force SGLS command station and the shuttle to Air Force payload command link, as illustrated in Figure 5-2.

The functions performed by these links are identical to the SGLS system just discussed. The primary difference is the use of a low-power command transmitter/receiver located on the shuttle itself to be used for initial control of Air Force payloads after release from the shuttle. Ultimate control and tracking of the Air Force satellites will continue to be accomplished with the six AFSCF stations.

Fleet Satellite Communication-C (FLTSATCOM-C)

The FLTSATCOM-C system will consist of various earth stations such as; AN/USC-38, AN/WSC-3, AN/WSC-5, AN/FSC-79, etc., and a constellation of eight satellites in equatorial geosynchronous orbits to provide global connectivity among naval aircraft, ships, submarine, and ground-based command centers. In addition, two other satellites may be stationed at spare positions. TABLE 5-4 lists the projected longitudinal positions of the FLTSATCOM-C satellites, including the spares.

TABLE 5-4

LONGITUDINAL POSITIONS OF THE FLTSATXOM-C SATELLITES

FLTSATCOM-C SATELLITES	LONGITUDINAL POSITIONS
Indian Ocean - 1	28E (Spare)
Indian Ocean - 2	72E
Indian Ocean - 3	75E
West Pacific - 1	172E
West Pacific - 2	177W
West Pacific - 3	145W (Spare)
East Pacific - 1	105W
East Pacific - 2	100W
East Atlantic - 1	22.5W
East Atlantic - 2	15W

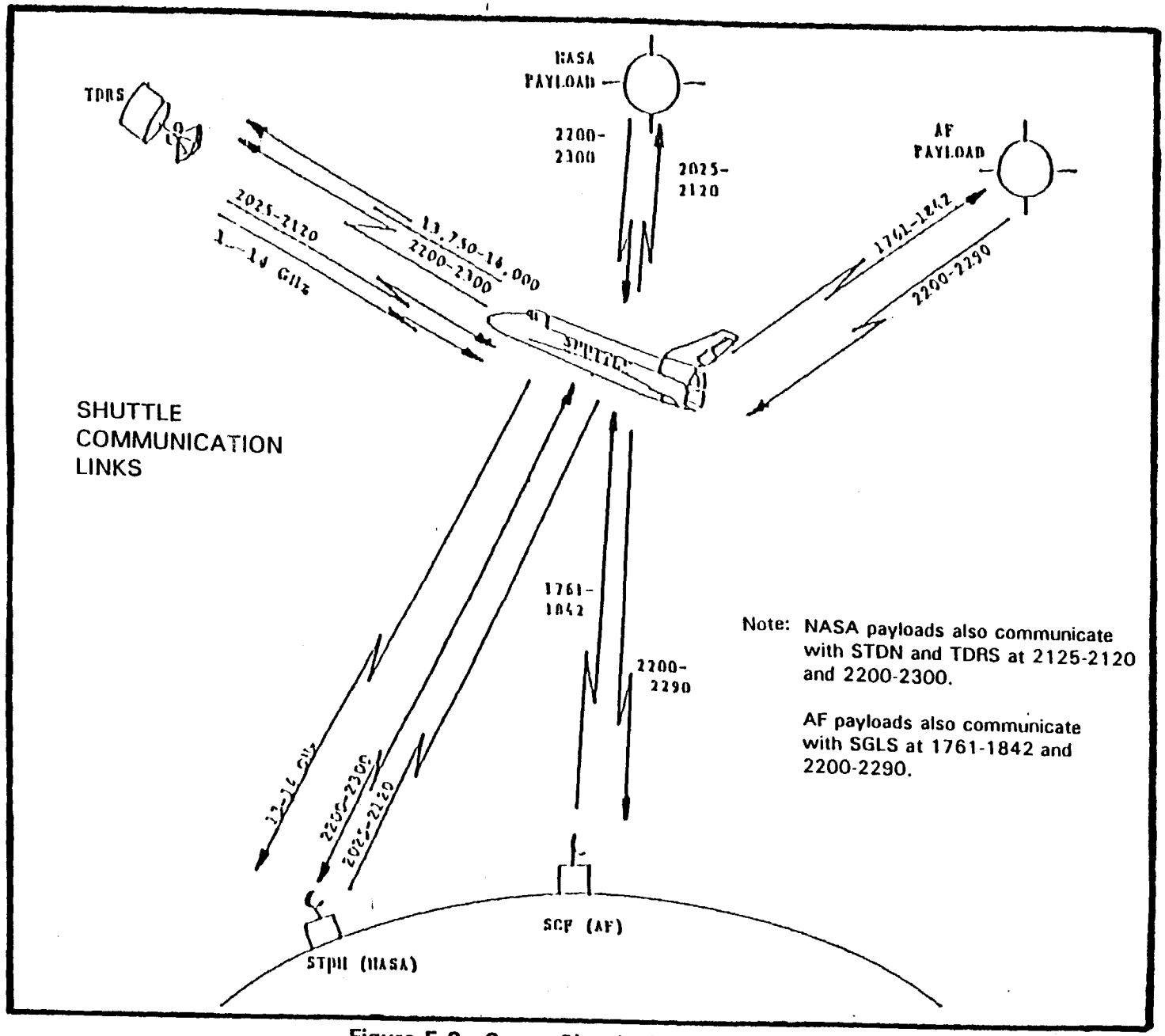

Figure 5-2. Space Shuttle Communication Links.

The FLTSATCOM-C system is comprised of several subsystems to operate in various frequencies and services. The subsystem of interest for this report is employed in the space operations service for telemetry and telecommand operations in the 1760-1840 MHz and 2200-2290 MHz frequency ranges. The system's line diagram, which includes the up- and down-links with their respective operational frequency ranges, is shown in Figure 5-3. The telemetry/telecommand subsystem will be utilized on FLTSATCOM-C satellites to transmit tracking and telemetry data to and receive tracking and telecommand data from Air Force SGLS terrestrial installations.

The intended frequencies of operation for the telemetry link are SGLS Channel 11 at 2252.5 MHz (primary) and SGLS Channel 13 at 2262.5 MHz (backup). While, the intended frequencies of operation for the telecommand link are SGLS Channel 11 at 1803.760 MHz (primary) and SGLS Channel 13 at 1811.768 MHz (backup). The FLTSATCOM-C system is intended to eventually replace the older generations of the Navy's FLTSATCOM.

Defense Satellite Communications Systems (DSCS)

The DSCS is an integral component of the global Defense Communications Systems (DCS). It is designed to provide vital command, control, and communications services to the U.S. and Allied Forces throughout the world by means of satellites. The DSCS provides reliable, large-capacity, quality communications capability in support of peacetime, contingency, and war operations. The DSCS provides the primary transmission path for much of the DOD's highest priority communications. It also offers a means of restoring other DCS transmission systems that may become inoperative. It is engineered and configured to satisfy validated Worldwide Military Command and Control System requirements. A unique feature of the DSCS is its capability to extend communication services to remote locations not adequately served by other means. The satellites were designed to operate in conjunction with a variety of earth station types, including fixed, land transportable, shipboard, and airborne, that use either frequency division, time division, or spread spectrum multiple access.

The DSCS space segment consists of both DSCS II and DSCS III satellites in a constellation that is configured to provide maximum mission support. The constellation normally consists of five operational satellites along with in-orbit spares. DSCS III satellites are intended to replace DSCS II satellites, and this replacement has already been accomplished in the Atlantic and East Pacific Ocean regions. An operational configuration of a DSCS III satellite network is illustrated in Figure 5-4. A total of 14 DSCS III satellites will be needed to maintain a fully operational system through the year 2001. There is an ongoing effort within the Air Force and

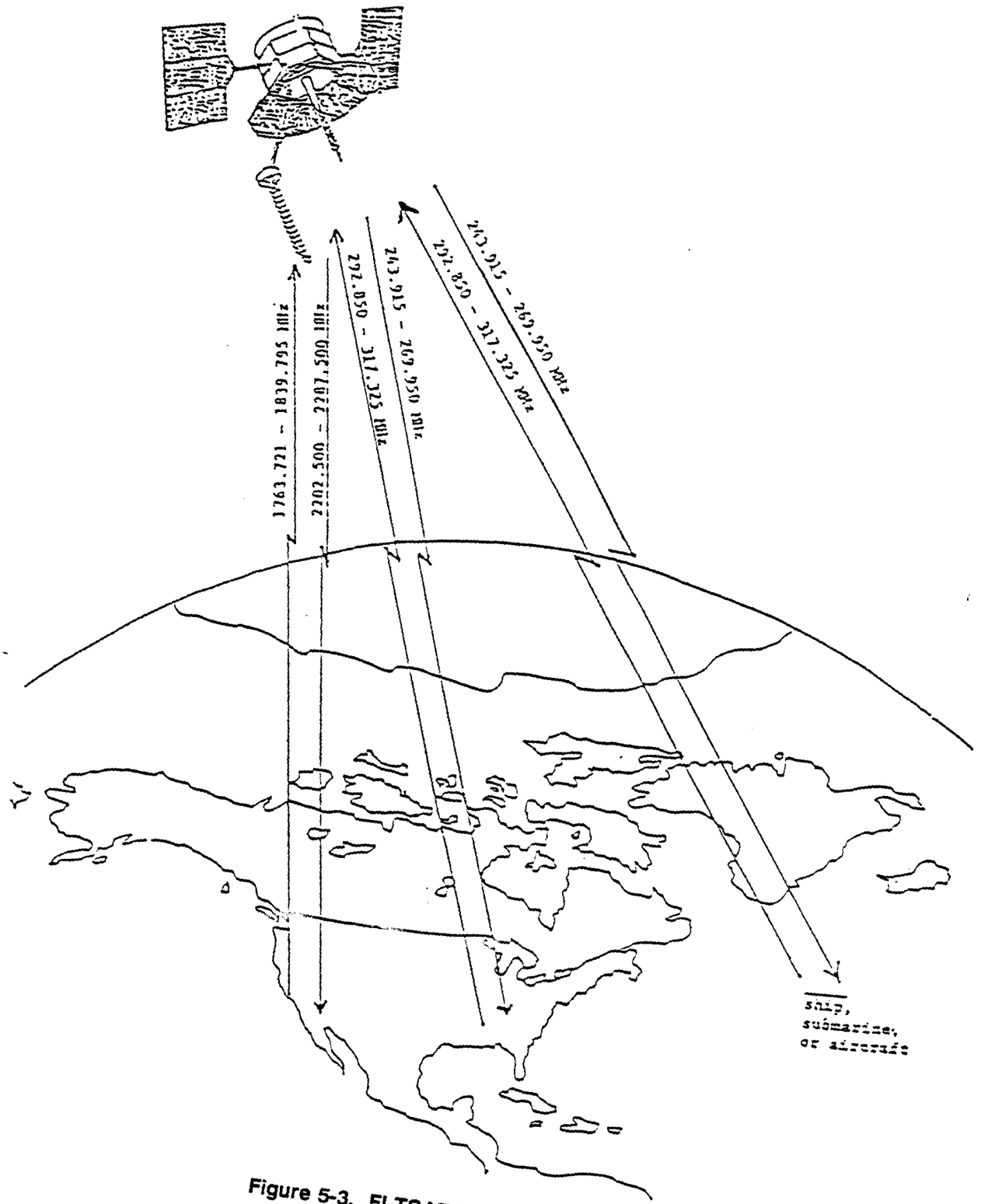

Figure 5-3. FLTSATCOM-C line diagram.